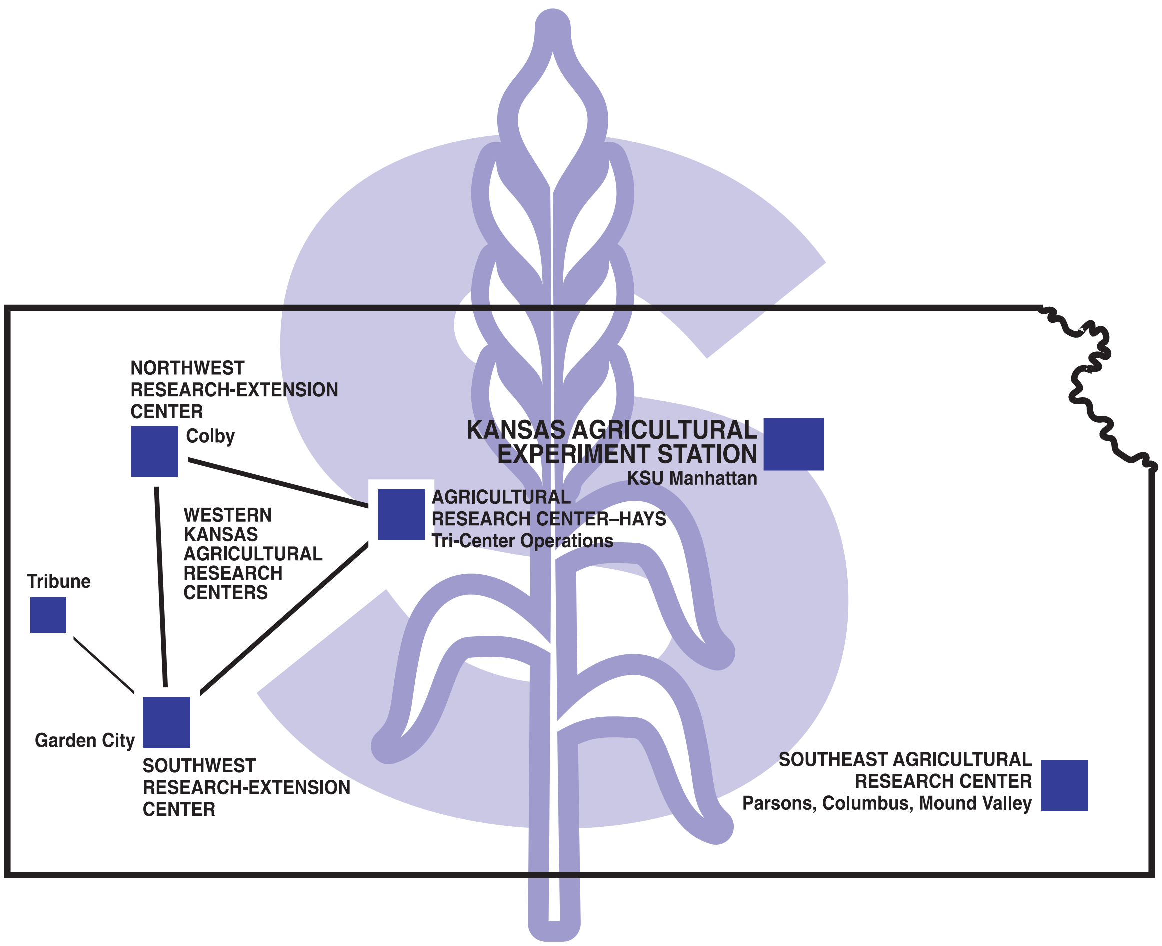
MF-2499

Economic Issues with Milling Hard White Wheat



Agricultural Industry Competitiveness

Enhance the Value of Kansas Agricultural Goods

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

Economic Issues with Milling Hard White Wheat

Kansas State University recently began releasing hard white wheat varieties. The rationale for hard white wheat, compared with hard red wheat, has been discussed in the publications *Hard White Wheat*, MF-1111 and *Economic Issues with White Wheat*, MF-2400. One advantage of hard white wheat commonly cited is the potential for an increase in the flour extraction rate. Hence, economic incentives for hard white wheat are likely going to be driven by the value of the increase in flour extraction. Another potential advantage of hard white wheat is that it may increase demand for U.S. wheat, because some importing countries prefer hard white wheat to hard red wheat. U.S. production of hard red wheat averaged 888 million bushels over the 1998/99 to 2000/01 marketing years compared to only 10.5 million bushels of hard white wheat.

Increasing the demand for U.S. hard white wheat would be supportive of the wheat market in general (i.e., both white and red wheat), but quantifying this amount is a complex issue and beyond the scope of this publication. Rather, this publication focuses on the milling properties of hard white wheat versus hard red wheat, and thus the objective of this publication is to determine the potential economic benefits from varying flour extraction rates.

Milling Hard Red and Hard White Wheat

There have been several studies that have examined the advantages of milling hard white wheat compared to hard red wheat. Vocke suggests that hard white wheat, when milled to color standards, yields 1 to 3 percent more flour than hard red. Hard red wheat must be milled at lower extraction rates to produce flour with the appropriate color characteristics for Asian noodles.

Evidence of a possible milling advantage for hard white wheat is supported by the fact that the bran from hard white wheat is white, lacking the tannins of hard red wheat. This lack of red color and tannins enables hard white wheat bran to be included in the flour milled from hard white wheat. Hard red wheat bran causes discoloration in noodle flour and a bitter taste in bread flour (Lin and Vocke). Bequette and Herrman, and Paulsen also alluded to the potential milling benefits of hard white wheat relative to hard red wheat.

The amount of endosperm in a wheat kernel and the ease of separating endosperm from bran determine flour extraction rate. A change in the flour extraction rate does not directly result in an identical change in the value of a bushel of wheat. Flour and mill feed are the two outputs when milling wheat. Mill feed, composed of bran and shorts or middlings, is used as an ingredient in animal feed rations. An increase in the flour extraction rate causes a reduction in mill feed and vice versa. Because flour has a greater value than mill feed, an increase in the flour extraction rate, all else equal, leads to greater value for a bushel of wheat.

Flour Extraction Example

The Wheat Marketing Center at Portland, Ore. conducted tests on various quality attributes of different hard white wheats from 1999 to 2001. This publication focuses on the varieties tested from Colorado, Kansas, and Nebraska, as these data should be relevant to Kansas wheat producers. Varieties tested were; Avalanche, Betty, Heyne, Lakin, NuPlains, Platte, and Trego. Not all varieties were tested from each state in each year of the 1999 to 2001 time period. These data are compared against average Gulf of Mexico export data for hard red wheat to calculate differences in the economic values of hard red and hard white wheats. The Gulf of Mexico export data for hard red wheat was chosen because hard white wheat has been positioned as a wheat designed for export. All of this wheat was chosen randomly from different states that harvested wheat and then analyzed at laboratories in Kansas City, Kan. and Portland, Ore.

Flour yield, defined as bushels of wheat required to produce 100 pounds of flour (hundredweight), is calculated by dividing 100 pounds by the test weight of the wheat variety and then dividing this figure by the flour extraction rate. Table 1 lists the test weights, flour extraction rates (milled for optimum milling yield), and calculated flour milling yields for the different white wheat varieties tested in Colorado, Kansas, and Nebraska in 1999 to 2001 and an average for hard red wheat each year. For example, in 2000 the variety Betty had a test weight of 60.9 pounds per bushel and a flour extraction rate of 73.1 percent. These values result in a flour milling yield of 2.25. In other words, it would take 2.25 bushels of wheat to produce 100 pounds of flour. Calculated this way, a low flour milling yield is preferred because it implies less wheat is required to produce a hundredweight of flour.

For the white wheat varieties listed in Table 1, the flour milling yield ranged from a low of 2.20

Table 1. *Quality Factors for Hard White Wheat Varieties and an Average Hard Red Wheat*[a]

Variety	Platte	Betty	Heyne	Trego	NuPlains	HWW	HRW[b]
State-Year	CO-1999	KS-1999	KS-1999	KS-1999	NE-1999	Avg-1999	Gulf-1999
Test Weight, lbs per bushel	64.7	61.9	61.1	62.1	62.4	62.4	58.8
Flour Extraction Rate, percent[c]	69.6	71.3	71.3	71.7	70.9	71.0	72.5
Flour Milling Yield, bu/cwt of flour[d]	2.22	2.27	2.30	2.25	2.26	2.26	2.35
Variety	Lakin	Betty	Heyne	Trego	NuPlains	HWW	HRW[b]
State-Year	KS-2000	KS-2000	KS-2000	KS-2000	NE-2000	Avg-2000	Gulf-2000
Test Weight, lbs per bushel	61.7	60.9	62.0	60.3	63.1	61.6	58.8
Flour Extraction Rate, percent[c]	73.0	73.1	71.4	71.9	72.1	72.3	67.8
Flour Milling Yield, bu/cwt of flour[d]	2.22	2.25	2.26	2.31	2.20	2.24	2.51
Variety	Avalanche			Trego	NuPlains	HWW	HRW[b]
State-Year	CO-2001			CO-2001	NE-2001	Avg-2001	Gulf-2001
Test Weight, lbs per bushel	59.6			59.4	62.0	60.3	60.5
Flour Extraction Rate, percent[c]	70.5			70.8	71.2	70.8	69.0
Flour Milling Yield, bu/cwt of flour[d]	2.38			2.38	2.27	2.34	2.40

[a] Source: U.S. Wheat Associates
[b] Average of Gulf Exported Hard Red Wheat
[c] Extraction Rate is based on optimum milling yield
[d] Calculated as 100 ÷ Test Weight ÷ Flour Extraction Rate × 100

Table 2. *Flour Milling Costs and Mill Feed Value for Hard White Wheat Varieties and an Average Hard Red Wheat*[a]

Variety	Platte	Betty	Heyne	Trego	NuPlains	HWW	HRW
State-Year	CO-1999	KS-1999	KS-1999	KS-1999	NE-1999	Avg-1999	Gulf-1999
Flour Milling Yield, bu/cwt of flour	2.22	2.27	2.30	2.25	2.26	2.26	2.35
Flour Milling Cost, $/cwt of flour[b]	$8.57	$8.76	$8.88	$8.69	$8.72	$8.72	$9.07
Mill Feed Yield, lbs/cwt of flour[c]	43.70	40.33	40.33	39.54	41.04	40.99	38.00
Mill Feed Value, $/cwt of flour[d]	$0.58	$0.53	$0.53	$0.52	$0.54	$0.54	$0.50
Net Flour Cost, $/cwt of flour[e]	$7.99	$8.23	$8.35	$8.16	$8.18	$8.18	$8.57
Variety	Lakin	Betty	Heyne	Trego	NuPlains	HWW	HRW
State-Year	KS-2000	KS-2000	KS-2000	KS-2000	NE-2000	Avg-2000	Gulf-2000
Flour Milling Yield, bu/cwt of flour	2.22	2.25	2.26	2.31	2.20	2.24	2.51
Flour Milling Cost, $/cwt of flour[b]	$8.57	$8.69	$8.72	$8.92	$8.49	$8.65	$9.69
Mill Feed Yield, lbs/cwt of flour[c]	36.98	36.86	40.07	39.14	38.70	38.22	47.52
Mill Feed Value, $/cwt of flour[d]	$0.49	$0.49	$0.53	$0.52	$0.51	$0.50	$0.63
Net Flour Cost, $/cwt of flour[e]	$8.08	$8.20	$8.19	$8.40	$7.98	$8.14	$9.06
Variety	Avalanche			Trego	NuPlains	HWW	HRW
State-Year	CO-2001			CO-2001	NE-2001	Avg-2001	Gulf-2001
Flour Milling Yield, bu/cwt of flour	2.38			2.38	2.27	2.34	2.40
Flour Milling Cost, $/cwt of flour[b]	$9.19			$9.19	$8.76	$9.03	$9.26
Mill Feed Yield, lbs/cwt of flour[c]	41.85			41.28	40.53	41.18	45.01
Mill Feed Value, $/cwt of flour[d]	$0.55			$0.54	$0.54	$0.54	$0.59
Net Flour Cost, $/cwt of flour[e]	$8.63			$8.64	$8.23	$8.49	$8.67

[a] See Table 1 for additional information and definitions
[b] Flour Milling Yield × Average Wheat Price of $3.86 per bushel
[c] Calculated as Flour Milling Yield × Test Weight × (1 - Flour Extraction Rate ÷ 100)
[d] Mill Feed Yield × Average Mill Feed Price of $1.32 per hundredweight (cwt)
[e] Net Flour Cost = Flour Milling Cost - Mill Feed Value

Table 3. *Flour Procurement Cost Differences Between Hard White Wheat Varieties and Average Hard Red Wheat*

Variety	Platte	Betty	Heyne	Trego	NuPlains	HWW	HRW
State-Year	CO-1999	KS-1999	KS-1999	KS-1999	NE-1999	Avg-1999	Gulf-1999
Flour Milling Cost Savings[a]	$0.50	$0.31	$0.19	$0.39	$0.35	$0.35	base
Mill Feed Value Loss[b]	-$0.08	-$0.03	-$0.03	-$0.02	-$0.04	-$0.04	base
Net Difference[c]	$0.58	$0.34	$0.22	$0.41	$0.39	$0.39	base
Per Bushel Difference[d]	$0.26	$0.15	$0.10	$0.18	$0.17	$0.17	base
Variety	Lakin	Betty	Heyne	Trego	NuPlains	HWW	HRW
State-Year	KS-2000	KS-2000	KS-2000	KS-2000	NE-2000	Avg-2000	Gulf-2000
Flour Milling Cost Savings[a]	$1.12	$1.00	$0.97	$0.77	$1.20	$1.04	base
Mill Feed Value Loss[b]	$0.14	$0.14	$0.10	$0.11	$0.12	$0.12	base
Net Difference[c]	$0.98	$0.86	$0.87	$0.66	$1.08	$0.92	base
Per Bushel Difference[d]	$0.44	$0.38	$0.38	$0.29	$0.49	$0.41	base
Variety	Avalanche			Trego	NuPlains	HWW	HRW
State-Year	CO-2001			CO-2001	NE-2001	Avg-2001	Gulf-2001
Flour Milling Cost Savings[a]	$0.08			$0.08	$0.50	$0.23	base
Mill Feed Value Loss[b]	$0.04			$0.05	$0.06	$0.05	base
Net Difference, $/cwt[c]	$0.04			$0.03	$0.44	$0.18	base
Net Difference, $/bushel[d]	$0.01			$0.01	$0.20	$0.08	base

[a] Difference between the average hard red wheat and the hard white wheat variety Flour Milling Cost in Table 2
[b] Difference between average hard red wheat and hard white wheat variety Mill Feed Value in Table 2
[c] Flour Milling Cost Savings less Mill Feed Value Loss
[d] Calculated as Net Difference, $/cwt divided by Flour Milling Yield (bushels/cwt of flour)

(NuPlains in Nebraska in 2000) to a high of 2.38 (Avalanche and Trego in Colorado in 2001). When comparing within a year, the flour milling yield of the hard white wheat varieties was always less than that of the hard red wheat.

The net cost of flour can be calculated for the different varieties given the information in Table 1 and prices for wheat and mill feed. Kansas City wheat and mill feed prices of $3.86 per bushel and $1.32 per hundredweight, respectively, were used for this analysis. These prices are 5-year averages (1996/97 to 2000/01 marketing years) from the *Milling and Baking News* and USDA Agricultural Marketing Service.

The cost of wheat in a hundredweight of flour is the flour milling yield multiplied by the price of wheat. Continuing our example with Betty, the cost of wheat in a hundredweight of flour for this variety is $8.69 (2.25 multiplied by $3.86). Table 2 shows the cost of wheat in a hundredweight of flour for each of the hard white wheat varieties as well as for hard red wheat by location and year. Based on the data in Table 1 and the price of $3.86 per bushel, hard white wheat had lower costs relative to the hard red wheat (Table 2). The simple average flour milling cost of the hard white wheat varieties is $8.72 (1999), $8.65 (2000), and $9.03 (2001) compared to hard red wheat costs of $9.07 (1999), $9.69 (2000), and $9.26 (2001).

The portion of the wheat that is not extracted as flour (i.e., 100 minus flour extraction rate) becomes wheat mill feed. The value of mill feed resulting from producing a hundredweight of flour can be calculated in a similar manner as the cost of wheat in a hundredweight of flour. The mill feed yield, measured in pounds of mill feed associated with producing 100 pounds of flour, is the product of flour milling yield, test weight, and the remaining wheat after the flour has been extracted (100 minus flour extraction rate). The mill feed value is simply the mill feed yield times the price of mill feed.

Again continuing with the example for Betty, the flour extraction rate is 73.1 percent (2000 in Kansas) indicating that 26.9 percent of the wheat remains as mill feed. Based on a flour milling yield of 2.25 bushels per hundredweight of flour and a test weight of 60.9 pounds per bushel, the mill feed yield would be 36.86 pounds per hundredweight of flour produced ($60.9 \times 2.25 \times 0.269$). Multiplying 36.86 by $0.0132 ($1.32 per hundredweight price converted to pounds by dividing by 100) equals a mill feed value of $0.49 per hundredweight of flour. Based on the data in Table 1 and the price assumption for wheat mill feed, the average value of mill feed for the white wheat varieties is $0.54 (1999), $0.50 (2000), and $0.54 (2001) compared to $0.50 (1999), $0.63 (2000), and $0.59 (2001) for the hard red wheat.

The net flour cost is simply the flour milling cost less the mill feed value. Thus, the net flour cost of the variety Betty (2000 in Kansas) is $8.20 per hundredweight of flour ($8.69 - $0.49).

Differences in the net flour milling procurement cost between the hard red wheat average from the Gulf of Mexico and the hard white wheat varieties are shown in Table 3. The net flour milling procurement cost is based on the cost of purchasing the wheat to produce flour less the value of the mill feed that is produced. In terms of the wheat cost required to produced 100 pounds of flour (i.e., flour milling cost in Table 2), the average of the hard white wheat varieties in 2000 had the greatest cost savings, relative to hard red wheat, at $1.04 per hundredweight of flour followed by the 1999 average ($0.35) and the 2001 average ($0.23). The individual variety with the highest savings was NuPlains in Nebraska in 2000 ($1.20) and the varieties with the lowest savings were Avalanche and Trego in Colorado in 2001 ($0.08).

Due to the inverse relationship between flour extraction rate and mill feed yield, there is a loss in mill feed value for the hard white wheat varieties when they have a higher extraction rate. However, in 1999 the hard red wheat had a higher extraction rate than the white wheat varieties and thus there is actually a gain in mill feed value for the hard white wheat varieties (the hard red wheat was still more costly in this year due to its low test weight).

In 1999 there was an average gain in mill feed value of $0.04 per hundredweight of flour produced for the white wheat varieties followed by losses of $0.05 and $0.12 in 2001 and 2000, respectively. The individual variety with the highest gain was Platte in Colorado in 1999 (gain of $0.08). The varieties with the biggest loss in mill feed value were Betty and Lakin in Kansas in 2000 (loss of $0.14).

What Does this Mean to a Producer?

Marketing contracts for hard white wheat (e.g., Betty and Heyne in 1999; Betty, Heyne, and Trego in 2000; Betty, Heyne, Trego, NuFrontier, and NuHorizon in 2001) in Kansas included premiums in the base price with additional premiums for quality (protein percentage) depending upon the program. The base premium was typically $0.10 per bushel. The cost savings for flour mills can be used to calculate premiums they may be willing to pay for wheat varieties that consistently provide a higher flour extraction rate.

Theoretically, any premium offered by a miller would be equal to the cost savings generated by the wheat with the greater flour extraction rate. This would be equal to the net procurement cost savings per hundredweight of flour divided by the number of bushels needed to produce a hundredweight of flour. In this case, converting the cost savings to a per bushel basis for the varieties considered here results in average per bushel savings ranging from $0.01 (Avalanche and Trego in Colorado in 2001) to $0.49 (NuPlains in Nebraska in 2000). Based on the 5-year average prices for wheat ($3.86/bu) and mill feed ($1.32/cwt), the average per bushel cost savings over the 3 years considered here is $0.22 ($0.17 in 1999, $0.41 in 2000, and $0.08 in 2001).

The factors impacting flour milling cost differences are extraction rate and test wheat and it must be noted that there is a great deal of variability when looking at this data. On average, the flour extraction rate for the hard white wheat varieties was 1.6 percent higher than for the hard red wheat (71.4 percent compared to 69.8 percent). However, this difference ranged from a low of –1.5 percent in 1999, when hard red wheat had a higher extraction rate, to a high of 4.5 percent in 2000. The 3-year average test weight of the hard white wheat varieties was 61.5 pounds per bushel compared to 59.4 pounds for hard red wheat for an average difference of 2.1 pounds. However, this difference ranged from –0.2 in 2001 (hard red wheat weighed more than hard white wheat) to 3.6 in 1999.

Examining the data on a year-by-year basis reveals why both extraction rate and test weight are critical in determining the potential flour cost savings for millers. In 1999, white wheat had a $0.17 per bushel advantage over hard red wheat in spite of having a lower extraction rate. This was because the test weight of white wheat was significantly higher in this year (62.4 versus 58.8). In 2000, hard white wheat had both a test weight advantage (61.6 versus 58.8) and a flour extraction rate advantage (72.3 percent versus 67.8 percent) resulting in a large cost savings of $0.41 per bushel. In 2001, test weights were comparable between white and red wheat (60.3 versus 60.5) and white wheat had a slight advantage in the flour extraction rate (70.8 percent versus 69.0 percent). This combination of test weight and extraction rate differences resulted in a small cost savings to flour millers of $0.08 per bushel. These three highly variable years reveal why it is critical to consider both flour extraction rate and test weight when considering flour milling cost differences between hard white and red wheat.

Because the information presented in Tables 1 through 3 are based on data from only 3 years and a limited number of varieties, producers are encouraged to consider other data. For example, test weight data are available for Betty, Heyne, Lakin, and Trego from 1999, 2000, and 2001 from the Western Kansas Winter Wheat Performance Tests (http://www.ksu.edu/kscpt/). In these trials the test weight of these white wheat varieties was greater than the average of Jagger, 2137, and TAM 107 (the most popular hard red wheat varieties in western Kansas) in 1999 and 2000, and equal in 2001. Over this 3-year time period, the test weight average of the hard white wheat varieties was 0.72 pounds higher than the average of Jagger, 2137, and TAM 107.

It should be noted that milling data on NuFrontier and NuHorizon are not available for wheat produced in Kansas. Data is available on these two varieties for Washington state. Using that data in a similar analysis as done in Tables 1 through 3 would suggest that those varieties had a net difference of $0.23 and $0.37 per bushel for NuFrontier and NuHorizon, respectively. However, caution should be used in extrapolating such test weight and extraction data to Kansas. These varieties are both licensed to General Mills.

Variation in returns between varieties is a function of price (i.e., premiums); production and marketing costs; and yield. Thus, while Table 3 shows the cost differences between several white wheat varieties from three states across 3 years and hard red wheat from a flour miller's perspective, the relevant measure for wheat producers is returns per acre. The theoretical cost savings shown in Table 3 represent what a flour miller could pass on in the form of price premiums. How these premiums are allocated between producers and grain handlers will depend on who incurs additional costs that may exist.

As part of a marketing contract, producers may be required to plant certified seed, potentially increasing their production costs if there is not an offsetting yield advantage. *Economic Issues with Certified and Farmer-Saved Seed*, MF-2498, used retail farm store price data for certified seed of private varieties and compared this with the cost of holding seed back after harvest. A yield advantage of two bushels was needed to equate the increased certified seed price and yield advantage with custom cleaned and treated farmer-saved seed when cash wheat prices were $2.50 per bushel or higher. On average, certified seed was $3.51 per bushel higher than farmer-saved seed in that analysis.

Another potential cost increase associated with hard white wheat has to do with identity preservation, which may be incurred at the producer level or at the grain handler (i.e., elevator) level. Herrman et al. found these costs to be approximately $0.02 per bushel for large commercial grain elevators operating at full capacity.

Given the magnitude of cost savings in Table 3 and the potential increased cost associated with producing and marketing white wheat, any premiums existing for hard white wheat varieties likely will depend on hard white wheat varieties yielding the same number (or better) of bushels per acre as hard red wheat varieties. If not, producers likely have little incentive to produce hard white wheat if its yield is lower than hard red wheats.

Betty and Heyne have not had such yield differentials over hard red varieties. However, Trego has been one of the top yielding performance trials at Kansas State University (http://www.ksu.edu/kscpt/). Smith notes that wheat producers plant different varieties of wheat and variety choice is determined primarily by expected yield and expected price. Variations in yields and prices driven by protein premiums (or hard white wheat premiums) are less likely to influence a producer's variety choice relative to expected yield and expected price.

Conclusion

In order for producers to plant white wheat varieties, millers will need to find cost savings that offset any increases in producer costs, which include the use of certified seed, possible decreases in yield, and handling. Costs associated with using certified seed and expenses from keeping the hard white and hard red wheat varieties separate from one another have been estimated to be as high as $0.33 per bushel (assuming that white wheat yields are the same as a comparable hard red wheat). The 1999 through 2001 data used in Tables 1 through 3 suggest that, on average, hard white wheat varieties do not have enough cost savings to offset the certified seed requirement. However, within individual years there are varieties with cost savings large enough to cover costs associated with planting and maintaining the identity of white wheat.

It should be noted that this quality data was available for only a limited number of varieties over 3 years and these results are sensitive to variables such as test weight and extraction rates, which may be difficult to predict in advance from year-to-year. In particular, differences in test weight are also likely responsible for some of the differences in cost savings.

The alternative is to not require certified seed and allow producers to use farmer-saved seed. However, in the short-run, this may not be possible because farmer-saved seed was not available until the fall of 2001. There were premiums in the past 3 years for hard white wheat, which helped offset the certified seed requirement. Thus, any potential yield increases in hard white wheat varieties and the ability to use farmer-saved seed are likely going to be the economic incentives producers will receive for adopting hard white wheat.

An effective identity-preserved program must have sufficient economic incentives to encourage producers to produce and sell hard white wheat that is free from any hard red wheat so as to avoid having the wheat classified as being mixed wheat, which is severely discounted, and enable a miller to realize cost savings from using a large volume of hard white wheat.

Identity-preserved programs for wheat have not seen widespread use in Kansas relative to the northern Great Plains or Pacific Northwest, where elevators routinely have to deal with two or more classes of wheat. If sufficient economic incentives do not exist, it will be difficult to develop effective identity-preserved systems with a certified seed requirement. In the short-run, millers may require producers to use certified seed for several years. If so, economic incentives must be great enough to offset the use of certified seed. In the long-run, these economic incentives may change once producers and grain elevators learn to manage hard white wheat identity-preserved programs.

References

Bequette, R.K. and T.J. Herrman. 1994. Hard White Wheat. K-State Research and Extension MF-1111. Kansas State University. Available online May 1, 2000. http://www.oznet.ksu.edu/library/grsci2/MF1111.PDF

Boland, M.A. and M. Howe. 1999. Economic Issues with White Wheat. K-State Research and Extension MF-2400, Kansas State University, Manhattan, KS. Available online September 28, 2000. http://www.oznet.ksu.edu/library/agec2/mf2400.pdf

Boland, M.A., K. Dhuyvetter, and M. Howe. 2000. Economic Issues with Certified and Farmer-Saved Wheat Seed. K-State Research and Extension MF-2498, Kansas State University, Manhattan, KS. Available online January 3, 2001. http://www.oznet.ksu.edu/library/agec2/mf2498.pdf

Herrman, T.J., M.A. Boland, K. Agrawal, and S.R. Baker. 2002. Use of a Simulation Model to Evaluate Wheat Segregation Strategies for Country Elevators. *Applied Transaction of the ASAE*, 18,1: 105-112

Lin, W. and G. Vocke. 1998. Hard White Wheat: Changing the Color of U.S. Wheat? Agricultural Outlook, August 1998, Economic Research Service, U.S. Department of Agriculture, pp. 17-20. Available online October 18, 2000. http://www.ers.usda.gov/epubs/pdf/agout/aug98/ao253e.pdf

Paulsen, G.M. 1998. Hard White Winter Wheat for Kansas. K-State Research and Extension SRL-120, Kansas State University, Manhattan, KS. Available online May 1, 2000. http://www.oznet.ksu.edu/library/crpsl2/srl120.pdf

Smith, V.H. 2000. Wheat Quality and Wheat Yields: Tradeoffs among Price, Yield, Profit, and Risk. In *2000 Wheat Basebook*, Economic Research Service-USDA.

U.S. Wheat Associates. 2000-2001. Crop Quality Report. Available online January 3, 2001. http://www.uswheat.org

Vocke, G. 1998. Noodle End-Use Characteristics for Wheat in East and Southeast Asia. In *Wheat Yearbook 1998*, Economic Research Service-USDA, pg. 33-35. Available online October 18, 2000. http://www.ers.usda.gov/epubs/pdf/wheat/noodle.pd

Michael Boland
Associate Professor
Department of Agricultural Economics

Kevin C. Dhuyvetter
Professor
Department of Agricultural Economics

This research was funded in part by the USDA Federal-State Marketing Improvement Program.

Kansas State University Agricultural Experiment Station and Cooperative Extension Service

MF-2499 May 2002